

REMARKS

Claim 35 is amended. Claims 35-74 are pending in the application.

Claims 35-74 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over various cited combinations of Besser (U.S. Patent No. 5,582,881), Marieb (U.S. Patent No. 5,909,635), Shan (U.S. Patent No. 6,140,228) and Colgan (U.S. Patent No. 5,925,933). The Examiner is reminded by direction to MPEP § 2143 that a proper obviousness rejection has the following three requirements: 1) there must be some suggestion or motivation to modify or combine reference teachings; 2) there must be a reasonable expectation of success; and 3) the combined references must teach or suggest all of the claim limitations. Claims 35-74 are allowable over the various cited combinations of Besser, Marieb, Colgan and Shan for at least the reason that the references, individually or as combined, fail to teach or suggest each and every limitation in any of those claims.

Independent claim 35 recites depositing at a temperature of at least 400°C a first layer comprising aluminum and, without letting the outermost portion of the first layer cool to below 360°C, depositing titanium on the first layer to form a second layer comprising an alloy of titanium and aluminum from the first layer, the alloy being formed during the depositing of the titanium. Claim 35 additionally recites subsequently depositing a third layer comprising titanium nitride on the second layer. Claim 35 has been amended to correct a clerical error. As noted by the Examiner at page 3 of the present Action, Besser fails to disclose or suggest the claim 35 recited forming the outermost portion of the aluminum layer at a temperature of at least 400°C or the recited deposition of titanium without letting the outermost portion of the first layer cool below 360°C. Accordingly, independent claim 35 is not rendered obvious by Besser.

The Examiner indicates at pages 7-8 of the present action that the combination of Besser and Marieb suggests the recited forming the titanium aluminum alloy during deposition of titanium without allowing the aluminum to cool below 360°C because Marieb “teaches of the deposition of the layers and then that heat is a range of about 350°C to 450°C is applied to accelerate the chemical reaction between the aluminum and the titanium”. The Examiner is reminded by direction to MPEP § 2141 that when applying 35 U.S.C. § 103 the claimed invention must be considered as a whole and, with direction to MPEP § 2143.03, that all words in a claim must be considered in judging the patentability of the claim against the prior art. Further, with direction to MPEP § 2142, “the Examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references”. The Examiner does not present any rationale as to how the Marieb disclosure suggests the claim 35 recited depositing of titanium on a first layer comprising aluminum without letting at least an outer portion of the first layer cool below 360°C and forming the alloy during the deposition of titanium. Accordingly, the Examiner’s burden has not been met.

Marieb discloses forming an aluminum comprising layer 110 and subsequently depositing a layer of titanium 120 (col. 3, ll. 3-12). Marieb discloses forming a layer of titanium nitride 130 on the second layer followed by processing utilizing conventional dry etching to form a conductive structure (col. 3, ll. 12-22). Marieb further discloses that after the conductive structure is formed a third titanium layer is formed over the conductive structure and discloses an application of heat to accelerate formation of $TiAl_3$. Applicant further directs attention to Marieb figure 1C and the accompanying text which discloses formation of discrete layers 110, 120, 130 and 140. Marieb subsequently discloses, with

reference to figure 1D, a chemical reaction accelerated by an application of heat to form the structure shown in figure 1D. Although as noted by the Examiner at page 8 of the present action "the mere sequence of statements is not a clear teaching that heat is applied after the deposition of the films", the Examiner does not indicated how the Marieb disclosure suggests or can be combined to suggest the claim 35 recited depositing titanium on a first layer comprising aluminum without allowing the outermost portion of the first layer cool below 360°C to form an alloy of titanium and aluminum during the deposition of titanium.

As discussed above, neither Besser nor Marieb disclose or reasonably suggest the claim 35 recited depositing titanium on a first layer comprising aluminum without letting the outermost portion of the first layer cool from deposition of the first layer to below 360°C to form a layer comprising an alloy of titanium and aluminum during the deposition of titanium.

The Examiner has not presented a convincing line of reasoning as to how the teachings of Besser and Marieb can be combined to suggest this recited feature. Accordingly, dependent claim 35 is not rendered obvious by the combination of Besser and Marieb.

As indicated in response to the previous action, Shan does not disclose or suggest the claim 35 recited depositing an outermost portion of a first layer comprising aluminum at a temperature of at least 400°C, and subsequently depositing titanium. Accordingly, Shan cannot suggest the recited depositing titanium on a first layer comprising aluminum without allowing an outermost portion of the first layer to cool below a temperature of 360°C. As further discussed in the previous response, Colgan discloses formation of an aluminum comprising layer followed by formation of a titanium layer and a titanium nitride layer followed by a subsequent heating step. Colgan does not disclose or suggest the claim 35

recited formation of a first layer comprising aluminum and the deposition of titanium on the first layer without letting an outermost portion of the first layer cool to form a titanium aluminum alloy during the deposition of titanium.

Not one of the four references relied upon by the Examiner discloses or suggest the claim 35 recited formation of a first layer and, without letting the first layer cool to below 360°C, depositing titanium to form an alloy during the titanium deposition. There is no apparent suggestion within the cited combination of this recited feature and a convincing line of reasoning as to why this feature would have been obvious in light of the teachings of the references was not set forth by the Examiner. Accordingly, independent claim 35 is not rendered obvious by the cited combination of Besser, Marieb, Colgan and Shan and is allowable over these references.

Dependent claims 36-48 are allowable over the cited combination of Besser, Marieb, Colgan and Shan for at least the reason that they depend from allowable base claim 35.

Each of independent claims 49 and 58 recite forming a first layer comprising aluminum at a temperature of at least 400°C, depositing titanium onto the first layer without letting an outermost portion of the first layer cool to a temperature below 360°C, and forming an alloy during the titanium deposition. Independent claims 49 and 58 are allowable for at least reasons similar to those discussed above with respect to independent claim 35.

Dependent claims 50-57 and 59-74 are allowable for at least the reason that they depend from corresponding allowable base claims 49 and 58.

For the reasons discussed above claims 35-74 are allowable. Accordingly, applicant respectfully requests formal allowance of pending claims 35-74 in the Examiner's next action.

Respectfully submitted,

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Title: Method of Forming an Aluminum Comprising Line Having a Titanium Nitride
Comprising Layer Thereon

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING
RESPONSE TO SEPTEMBER 10, 2002 FINAL OFFICE ACTION

In the Claims

The claims have been amended as follows. Underlines indicate insertions and
strikeouts indicate deletions.

35. (Amended) A method of forming an aluminum comprising line having a titanium nitride comprising layer thereon, the method comprising:

in a processing tool, physical vapor depositing a first layer comprising at least one of elemental aluminum or an aluminum alloy over a substrate in a first chamber, at least an outermost portion of the first layer being deposited at a first deposition temperature of at least 400°C;

after the first layer physical vapor depositing and without letting the outermost portion of the first layer cool from the first deposition temperature to a temperature below 360°C, physical vapor depositing at least one of elemental titanium or a titanium alloy on the first layer in a second chamber of the processing tool while at least an outer portion of the first layer is at a temperature of at least about 360°C, and forming therefrom a second layer comprising an alloy of titanium and the aluminum from the first layer in the second chamber during said depositing, the alloy having a higher melting point than that of the first layer, and wherein essentially all the physical vapor deposited titanium alloys with the aluminum of the first layer;

physical vapor depositing a third layer comprising titanium nitride on the second layer;

removing the substrate from the processing tool after depositing the third layer; and forming the first, second and third layers into a conductive line.

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